wet seasons in southern California. But the partially dry seasons of 1912–13 should properly be eliminated from this count, because its July and August rains, when traced to their origin with the aid of the Weather Bureau maps, are seen to be a result of the westward extension of interior LOWS, and therefore are rains from LOWS that did not come off the Pacific Ocean. Consequently, when we consider only the appreciable summer rains at San Diego due to LOWS that came in from the Pacific, *there are 19 seasons out of 20 that preceded average to wet seasons in southern California*, indicating a 95 per cent probability of similar occurrences for the future. The only regrettable fact is the infrequency with which these "average" summer rains occur.

TABLE 3.—*San Diego summer rains in relation to the ensuing rainy season in southern California*

Season	San Diego summer rainfall (normal 0.24")	Seasonal rainfall at—					
		Los Angeles (normal 15.62")	Redlands (normal 14.55")	Riverside (normal 10.74")	San Bernardino (normal 16.04")	San Diego (normal 9.70")	Tustin (normal 13.04")
1852–53	0.40					11.03	
1853–54	.21					9.77	
1854–55	1.52					13.56	
1861–62	1.59					15.64	
1863–64	.36					5.14	
1865–66	1.29					12.82	
1867–68	.30					11.23	
1868–69	.56					11.68	
1873–74	1.95				23.81	7.88	
1874–75	.25				13.65	5.73	
1875–76	.60				19.90	10.11	
1880–81	.41	13.13			13.50	9.66	9.49
1890–91	.65	13.36	19.06	12.89	18.08	10.47	14.76
1902–3	.92	19.32	15.82	12.74	17.42	11.76	15.85
1905–6	.66	18.65	16.61	15.14	19.88	14.68	19.00
1906–7	.22	19.30	21.85	16.31	23.17	10.62	19.68
1908–9	.84	19.18	14.47	12.02	17.36	10.23	14.45
1912–13	.40	13.42	7.96	7.16	11.08	5.87	8.11
1916–17	.28	15.26	14.07	9.11	13.79	10.13	10.38
1919–20	.36	12.52	15.82	12.00	19.28	9.00	13.03
1920–21	1.24	19.66	25.50	19.75	27.75	18.65	17.51

In this connection, as with the results from my consideration of Santa Barbara rains, it should be stated that this high probability by no means indicates that we can forecast *in general* the seasonal rainfall from the summer rainfall. If the summer is "dry," it has no significance whatever in relation to the ensuing season's rainfall, for many wet seasons have followed almost rainless summers. But when the average to heavy summer rains do come, then the high probability above shown applies.

On examining the seasons above discussed, I find that nearly all of them had the South Pacific LOWS of September or October. When they have both the LOWS and the rains, the wetness of the coming rainy season is further assured.

DISCUSSION

By A. J. HENRY

The two articles immediately preceding deal with a question of great scientific and economic importance.

Blochman presents statistical evidence of the tendency of the weather to persist for a time in the same sense, an idea that has been discussed for some years in Europe. Von Hann in his Lehrbuch, third edition, refers to it under the caption "Die Erhaltungstendenz der Witterungstypen."[1] Others have alluded to it in connection with seasonal forecasting and only very recently Weise has computed the correlation coefficients between pairs of months, January–February, March–April, etc., for the 165-year temperature record for Leningrad,[2] first for the record as a whole, then for the three 50-year periods and finally for each of the five 30-year periods. The significant result is reached that the coefficients for corresponding pairs of months in some of the 30-year periods differ very materially from each other, whereas in the longer periods the coefficients are fairly uniform as between the several parts of the record.

Doctor McEwen utilizes ocean surface temperatures along the coast of southern California as an index to the pressure over the northeast Pacific and endeavors to pass from ocean pressures to the rains in a limited section of southern California six months later. The rather striking thing about this purely empirical method is that it gives the correct sign of the rainfall departure in eight out of nine cases, although the absolute amounts of rain are not indicated so closely.

Doctor McEwen in attempting to set forth his conception of the physical relations involved in the production of wet and dry years in California, is fully conscious of the difficulty of coordinating the very few facts at hand, and he therefore makes certain basic assumptions, some of which, in the view of the present writer may not be in accord with theory and experience. It is a question, indeed, whether scientific research of the present day is sufficiently well organized and equipped to cope with the truly great problem of seasonal weather forecasting, involving as it does the entire atmosphere of the globe. For more than 50 years meteorologists have been observing and charting the paths of anticyclones and cyclones; yet in all this time they have scarcely passed beyond the observing stage, for very little is yet known of the precise method of origin of these formations and the source of their maintenance as they travel over the face of the globe.

Out of the fifty-odd years of study have come the facts that cyclones with their attendant rain and cloud seemingly prefer to remain over the oceans in winter rather than pass on to the continents; also that their fullest development takes place over the oceans rather than the land.

It is also generally recognized that low surface temperatures over the land in winter, the presence of anticyclonic wind systems and perhaps still other causes, not yet clearly recognized, obstruct the free movement of cyclones especially over the land. These are some of the reasons why cyclones coming from the Pacific tend to incline toward the Gulf of Mexico and to enter the continent below 45° north latitude in some winters and not in others.

The rainfall in California is conditioned upon the pressure distribution over the Pacific to the west and also over the Great Basin and plateau region of western United States. In winter what may be called the North Pacific statistical anticyclone is at a minimum, and coincidently therewith the statistical anticyclone of the Great Basin is at a maximum. While the intensity of the latter by reason of being over the continent can be precisely delimited each winter, its oceanic counterpart is practically unknown.

It seems reasonable to endeavor to connect, as Doctor McEwen has attempted to do, the North Pacific statistical anticyclone with the weather in the United States. The descriptive term "statistical" is used to connote a pressure formation that is based upon the average pressures over a period longer than 24 hours, generally for a month.

[1] Lehrbuch der Meteorologie dritte auflage seite 629. See also Georgii, Walter: Wettervorhersage. Dresden, 1924.

[2] Met. Zeit. 42: 217–225, Wiese W, studien uber die Erhaltungstendenz der mittleren monatlichen Temperaturanomalien.

A study has been made of the monthly mean pressures, the prevailing winds, and their average speed for the two Pacific stations, Midway Island and Honolulu, also for the California coast stations with a view of discovering whether these marginal stations of the North Pacific statistical anticyclone show any evidence of fluctuations which might reasonably be ascribed to changes in the intensity or the geographic position of the latter. The result is a negative one, although it may be mentioned that the coastal stations give evidence of a continental rather than an oceanic control.

Anticyclones, whether of the daily migrating or the statistical sort, have a clearly recognized tendency to move equatorward and thus to successively pass into warmer and warmer regions. The winds in these formations blow outward at the surface and unless there is a corresponding inflow aloft, of which the evidence is either vague or lacking entirely, the anticyclone as such must carry within its organization the seeds of early dissolution.

Following the line of thought in the preceding paragraph, we are led to the conclusion that high pressure in the North Pacific statistical anticyclone in August, let us say, will not endure as such beyond a month or so at the utmost, and can not therefore be a significant factor in the weather of the Pacific coast six months later. This is not said with an air of finality, but rather it is what the writer's study and experience would lead him to expect.

The method of correlation coefficients does not yield significant results, nor could it be expected to do so, because no representative station lies within the central portion of the anticyclone we are considering. The greatest obstacle to reaching an early decision as to the influence of the pressure in late summer upon the weather of western United States six months later is the lack of pressure observations in the northeast Pacific or more specifically in the region included between the parallels of 35° to 50° north and the meridians of 135° to 170° west longtitude. Few ships navigate the central region of high pressure and the probability of an increase in the number of ships' reports is rather remote. What is needed is an exploring vessel to cruise in the region above outlined taking and reporting by radio, meteorogical observations daily for a period of, say, five years. More usable information will thus be accumulated than will be obtained in the next 50 years if we depend upon the voluntary taking of meterorological observations by what few ships navigate this area.

THE RAIN-BEARING WINDS AT ATLANTA, GA.

By CHARLES F. VON HERRMANN

[Weather Bureau, Atlanta, Ga.]

If almost any one in the eastern part of the United States be asked the question, "From what direction does the wind mostly blow during rain?" the answer will almost invariably be: "From an easterly direction, and when the wind shifts to northwest the weather will soon clear." However, in meteorology as well as in other sciences in order to be sure that a statement of this kind is correct we must have exact measurements. The most recent textbooks on meteorology do not discuss the subject of the rain-bearing winds in any detail, nor do the very complete reports on The Climate of Baltimore, by Fassig, and on the Weather and Climate of Chicago, by Cox and Armington, contain any information on this subject. Therefore it was thought worth while to investigate the matter carefully for a representative eastern station such as Atlanta.

Automatic hourly records of precipitation are available at Atlanta for the 20-year period from 1905 to 1924, inclusive, all taken at the same locality. The record includes the winter season. The occurrence of snow at Atlanta is so rare that on the few occasions when snow has fallen without melting as it fell the hourly amounts were estimated with a fair degree of accuracy and these estimates have been included to make the record complete. Accordingly the amount of rainfall for every hour, including traces, together with the prevailing direction of the wind during each hour and its velocity have been assembled for the entire period and tabulated by months and years.

Summarizing these results in Table 1, the hourly rainfalls and the corresponding prevailing hourly wind directions at the time of the rain, are given in percentages of the total, for eight wind directions, together with the mean velocities for the same directions. The total number of rain-wind hours for the 20 years is 19,311, the total rainfall 968.01 inches, and the mean wind velocity during rain-wind hours 9.7 miles per hour (against a mean velocity for all winds of 11.1 miles per hour), with the elevation of the anemometer always at 216 feet. The wind was calm during rain only three or four times during the period, and in these few instances a wind direction was assumed corresponding to the direction recorded during the preceding hour.

TABLE 1.—*Prevailing winds, amounts of precipitation, and average wind velocities during hours with rain*

Direction	Per cent	Amounts of precipitation (per cent)	Wind velocities (means)
North	3.9	4.9	5.6
Northeast	11.9	12.2	7.8
East	22.4	17.6	10.7
Southeast	20.7	20.3	11.5
South	10.8	12.4	9.0
Southwest	7.6	8.0	9.5
West	10.2	10.8	11.8
Northwest	12.5	13.8	11.7

The necessity for exact measurements is at once shown by the results of the investigation, for the answer given by the layman to the question, "What are the rain-bearing winds?" turns out to be only partially correct. For while the largest amounts of precipitation do occur with east and southeast winds, it happens that northwest winds are next in order and not last. In fact during May, June, possibly July, and August the greatest rainfall occurs with northwesterly winds and not with easterly winds. The exact results have considerable importance in making local weather forecasts for Atlanta and will be given in some detail here.

Results.—The most frequent direction of the wind at Atlanta during rain is east (22.4 per cent), but the largest amount of precipitation occurs with southeast winds (20.3 per cent). Northeast, east, and southeast winds together constitute 55 per cent of the rain-bearing winds, and the amount of precipitation is 50 per cent of the total. Next to the east and southeast, however, the